Maternal depression and infant growth – a review of recent evidence

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Abstract

Depressive disorder occurring during pregnancy and the post-natal period (maternal depression) is common in both developed and developing countries. It can cause functional impairment at a time when the mother is performing tasks vital to her infant's growth and development. This article reviews recent research investigating whether there is an association between maternal depression and infant growth impairment. A search was made using Medline for articles published in the last 10 years, and the results were scrutinized for relevance and quality. Eight studies from developing countries, and three from the UK, are described. Cohort studies from both India and Pakistan provide evidence that maternal depression is an independent risk factor for poor infant growth. However, studies from other developing countries are limited and conflicting in their findings. The UK-based research suggests that such an association occurs in mothers/infants living in conditions of socio-economic deprivation. This review discusses the potential mechanisms by which the relationship between maternal depression and infant growth outcomes may be explained: the effect of infant growth 'failure' upon maternal mood; the impact of maternal depression upon health-seeking behaviours, breastfeeding and mother–child interaction; the relationship between antenatal depression and low infant birthweight; and economic, socio-cultural and confounding factors that may explain the variation between results from different settings.

Keywords: depression, post-natal, antenatal, infant growth, malnutrition, failure to thrive.

Introduction

Nurturing and feeding an infant requires tenacity, patience and concentration. Normally, the mother (this review will focus on the mother as the most usual primary carer) will be encouraged in this task by the positive feedback of watching her healthy growing child, and through the pleasure of their developing relationship. A depressed mother, however, may no longer enjoy her interaction with her child or take pride in her own actions. She may be tired, unable to concentrate and preoccupied by feelings of guilt, worthlessness and hopelessness.

It is therefore reasonable to hypothesize that depression in mothers could adversely impact upon

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infant nutritional status. This article will review recent research that has sought to investigate whether such an association exists. After providing a brief background to maternal depression and ways in which it can be measured, the review will critically describe the growing literature on maternal depression/infant growth from developing countries, along with three recent studies from the UK. It will describe the potential mechanisms mediating such an association, and discuss how variation between study results might be understood. Finally, it will point towards future research that may help answer the many outstanding questions left in this important field.

Search methodology

A search was made using Medline for articles published in the last 10 years (1996–2006). Search terms 'infant', 'nutrition', 'malnutrition', 'postpartum', 'postnatal', 'antenatal', 'mental' and 'depression' were combined. The results were scrutinized for relevance and quality. As only a small number of articles were found, none were excluded on the basis of methodological considerations, but concerns regarding study quality and design are discussed. The older literature is not formally reviewed, but reference is made to it as appropriate.

The impact of maternal depression on child development

Depression occurring in the post-natal period is common among women in both developed and developing countries (Halbreich & Karkun 2006), with recorded prevalences of 28% in Pakistan (Rahman *et al*. 2003), 34.7% in South Africa (Cooper *et al*. 1999), and 13.8% in the UK (Cox *et al*. 1993). Women depressed post-natally will often have also been depressed antenatally (Rahman *et al*. 2004a). The term maternal depression is used in this review and refers to depression during pregnancy and the first 1–2 years after childbirth.

There is robust evidence that post-natal depression is a risk factor for impairment in infant psychoemotional development, with these deficits persisting to at least school age (Murray & Cooper 1997). This understanding prompted investigation into whether it also impacts upon infant physical health, particularly growth. It was predicted that it would impact most severely on infant growth in environments which are 'hostile' to successful child rearing (in terms of economic resources, hygiene and healthcare availability), as there would be less of a nutritional 'safety-net' for the infants of depressed and struggling mothers (Rahman *et al*. 2002). Thus, research has been focused in low-income countries, where the issue is of high public health importance given the huge burden of infant undernutrition.

Measuring maternal mental health

Research in this area requires tools for measuring maternal depressive disorder. Reliable psychiatric diagnoses can be made only using a standardized clinical interview that elicits each symptom in detail. Such diagnostic interviews include the Structured Clinical Interview for DSM-IV (*Diagnostic and Statistical Manual of Mental Disorders*, 4th edn) (SCID) (First *et al*. 2002) and Schedules for Clinical Assessment in Neuropsychiatry [World Health Organization (WHO) 1994a]. Depressive symptoms can be efficiently measured using screening questionnaires. Although not diagnostic, these can be used as proxy measures of depressive disorder after validation against interviews such as the SCID. Examples of well-validated screening instruments used in the studies below are the Edinburgh Post-natal Depression Scale (EPDS), a 10-item scale routinely used to identify maternal depression in the UK (Cox *et al*. 1987), and the Self Reporting Questionnaire, a 20-item questionnaire designed by the WHO (1994b) for use in developing countries.

Study designs

Published studies have been of two broad designs: cross-sectional and cohort. In the cross-sectional studies, underweight and control infants were recruited, and the prevalence of depression in the mothers of the two groups was compared. In the cohort studies, maternal depression was measured antenatally or in the early post-natal period, and the

subsequent growth of the infants of depressed and non-depressed mothers was compared.

Cross-sectional studies from developing countries

These studies are shown in Table 1. Those conducted in Asia have all found an association between maternal depression and infant growth. Rahman *et al*. (2004b) compared the prevalence of depressive symptoms in mothers of low-weight infants vs. mothers of normal-weight infants at an immunization clinic in a relatively well-off area of Rawalpindi, Pakistan. After adjusting for potential confounders, the odds ratio between cases and controls for poor maternal mental health was 2.8 (95% CI 1.2–6.8). In a study in a poor rural area near Vellore, India (Anoop *et al*. 2004), undernourished infants were identified from a community health database and compared with matched normal-weight controls for the presence of current maternal depression and *recalled* maternal depression in the first month postpartum. On univariate analysis, current major depression was associated with infant underweight (OR 3.2, 95% CI 1.1–9.5), although this association was no longer significant after adjustment for confounders (OR 3.1, 95% CI 0.9–9.7). However, recalled depression occurring in the first month postpartum was significantly associated with infant being underweight (OR 5.0, 95% CI 1.0–24.0), and remained so after multivariate analysis (OR 7.8, 95% CI 1.6–38.5).

Harpham *et al*. (2005), as part of the 'Young Lives' project, recruited large community samples from Vietnam, Ethiopia, Peru and India (Andhra Pradesh). In each country, approximately 2000 infants aged 6–18 months were randomly recruited from the population of all such infants in 20 sites representative of a range of environments. A response rate of >90% was achieved. After adjustment for confounders, a significant association between maternal common mental disorder (CMD; depression/anxiety/somatization) and stunting was found in India (OR 1.4, 95% CI 1.2–1.6), and between maternal CMD and infant underweight in Vietnam (OR 1.4, 95% CI 1.1–1.8).

However, the published studies conducted outside of Asia have, with one exception, been negative. In the Ethiopia and Peru arms of the 'Young Lives' study, no association was found between infant stunting/underweight and maternal depression. In a primary care-based study in Jamaica, Baker-Henningham *et al*. (2003) recruited infants from clinics in poor urban areas. The prevalence of depressive symptoms was significantly higher among the mothers of the cases than controls, although these were measured with an instrument that was modified by the group and had not been formally validated in Jamaica. After accounting for confounding variables, maternal depression was not found to be an independent risk factor for infant undernutrition, which was instead largely predicted by indicators of poverty. However, a similar study based in two primary care clinics in a poor area on the outskirts of São Paulo, Brazil (de Miranda *et al*. 1996), did demonstrate an association, with 63% of mothers of malnourished children scoring above cut-off on the depression screening tool vs. 38% of mothers of normal-weight children (OR 2.8, 95% CI 1.2–6.9). This association persisted after adjusting for measured confounders.

Cohort studies from developing countries

Cross-sectional studies are unable to determine the direction of the association between maternal depression and infant growth; that is, maternal depression may be a risk factor for poor infant growth, or having a poorly growing child may be a precipitant to maternal depression. Cohort studies overcome this problem. They are shown in Table 2.

In a community-based study undertaken in a rural district outside Rawalpindi, Pakistan (Rahman *et al*. 2004a), women were recruited in the third trimester of pregnancy. Those found to be suffering from current major depressive episode were age-matched with non-depressed mothers. Data on education, body mass index (BMI), socio-economic status, family size and structure were also gathered. Infants of mothers depressed during pregnancy were significantly more likely to be both underweight and stunted at 2, 6 and 12 months, and this association persisted after

Table 1. Cross-sectional studies from developing countries

	Country	Study design	Setting	Sample size	Infant age in months [mean (SD)]	Infant growth outcome measures	% of sample who were cases	Maternal depression measure	Prevalence of maternal depression	Uncorrected association between infant outcome and maternal depression [OR (95% CI)]	Association corrected for confounders [OR (95% CI)]
Asia											
Rahman *et al.* (2004b)	Pakistan	Case–control	Urban immunization clinic	172	Cases 9.7 (0.9) Controls 9.7 (0.9)	*Underweight:* Cases: weight-for-age < 3rd centile Controls: weight-for-age > 10th centile	48%	SRQ cut-off 11/12	Cases 57% Controls 25%	3.9 (1.9–7.8)	2.8 (1.2–6.8)
Anoop *et al.* (2004)	India	Case–control (matched)	Recruitment from community health database	144	Cases 10.5 (1.6) Controls 10.6 (1.5)	*Underweight:* Cases: weight-for-age 50–80% of expected Controls: weight-for-age > 80% of expected	50%	SCID, major depressive episode (current and recalled early postpartum)	*Current:* Cases 19.4% Controls 6.9% *Recalled:* Cases 12.5% Controls 2.8%	*Current:* 3.2 (1.1–9.5) *Recalled:* 5.0 (1.0–24.0)	*Current:* 3.1 (0.9–9.7) *Recalled:* 7.4 (1.6–38.5)
Harpham *et al.* (2005)	India	Community-based survey	20 rural/urban representative study areas	1823	12 (range 6–18)	*Underweight:* cases: WAZ < –2 *Stunting:* cases: HAZ < –2	Underweight 45% Stunted 27%	SRQ cut-off 7/8	Overall 30%	*Underweight:* 1.3 (1.1–1.7) *Stunting:* 1.6 (1.3–1.9)	*Underweight:* 1.1 (0.9–1.4) *Stunting:* 1.4 (1.2–1.6)
Harpham *et al.* (2005)	Vietnam	Community-based survey	20 rural/urban representative study areas	1570	12 (range 6–18)	*Underweight:* cases: WAZ < –2 *Stunting:* cases: HAZ < –2	Underweight 23% Stunted 16%	SRQ cut-off 7/8	Overall 21%	*Underweight:* 1.5 (1.2–1.9) *Stunting:* 1.4 (1.1–1.7)	*Underweight:* 1.4 (1.1–1.8) *Stunting:* 1.3 (0.9–1.7)

Table 1. Continued

	Country	Study design	Setting	Sample size	Infant age in months [mean (SD)]	Infant growth outcome measures	% of sample who were cases	Maternal depression measure	Prevalence of maternal depression	Uncorrected association between infant outcome and maternal depression [OR (95% CI)]	Association corrected for confounders [OR (95% CI)]
Americas											
Baker-Henningham *et al.* (2003)	Jamaica	Case–control	Primarily urban primary care clinics	210	Cases 18.5 (5.0) Controls 19.4 (4.8)	*Underweight:* Cases: history of WAZ < –2 and current WAZ of < –1.5 Controls: WAZ > –1, no history of malnutrition	66%	CES-D (modified)	Mean score: Cases: 26 (SD 0–91) Controls: 16.5 (SD 0–86)	*t*-test for difference between mean scores on modified CES-D $P < 0.01$	Non-significant
De Miranda *et al.* (1996)	Brazil	Case–control	Primary care clinic in peri-urban shanty town	139	Cases 10.9 (6.9) Controls 8.4 (4.8)	*Underweight:* cases: <75% expected weight-for-age	57%	QMPA	Cases 63% Controls 38%	2.8 (1.2–6.9)	2.6 (CI not given)
Harpham *et al.* (2005)	Peru	Community-based survey	20 rural/urban representative study areas	1949	12 (range 6–18)	*Underweight:* cases: WAZ < –2 *Stunting:* cases: HAZ < –2	Underweight 10% Stunting 25%	SRQ cut-off 7/8	Overall 30%	*Underweight:* 1.1 (0.8–1.4) *Stunting:* 1.2 (1.0–1.5)	*Underweight:* 0.8 (0.6–1.2) *Stunting:* 1.1 (0.9–1.4)
Africa											
Harpham *et al.* (2005)	Ethiopia	Community-based survey	20 rural/urban representative study areas	1722	12 (range 6–18)	*Underweight:* cases: WAZ < –2 *Stunting:* cases: HAZ < –2	Underweight 42% Stunting 38%	SRQ cut-off 7/8	Overall 33%	*Underweight:* 1.2 (1.0–1.4) *Stunting:* 0.9 (0.8–1.2)	*Underweight:* 1.1 (0.9–1.4) *Stunting:* 0.9 (0.7–1.2)

OR, odds ratio; WAZ, weight-for-age *z*-score; HAZ, height-for-age *z*-score; SRQ, Self Reporting Questionnaire; SCID, Structured Clinical Interview for DSM-IV; CES-D, Centre for Epidemiological Studies Depression Scale; QMPA, Adult Psychiatric Morbidity Questionnaire.

Table 2. Cohort studies from developing countries

	Country	Study setting	Sample size	Maternal depression measure	Depression prevalence in study population	Timing of recruitment	Infant outcome measures	Infant age at follow-up (months)	Uncorrected association between infant outcome and maternal depression	Association between infant outcome and maternal depression corrected for confounders
Rahman *et al.* (2004a)	Pakistan	Rural, community based	265 (129 depressed, 136 age-matched non-depressed)	SCAN, major depressive episode	25%	Antenatal (3rd trimester, mean 6/52 from delivery)	*Underweight:* WAZ < –2 *Stunting:* HAZ < –2	2, 6 and 12	*Underweight* [RR (CI)]: 6 months: 4.0 (2.1–7.7) 12 months: 2.6 (1.7–4.1) *Stunting* [RR (CI)]: 6 months: 4.4 (1.7–11.4) 12 months: 2.5 (1.5–4.0)	*Underweight* [OR (CI)]: 6 months: 3.5 (1.5–8.6) 12 months: 3.0 (1.5–6.0) *Stunting* [OR (CI)]: 6 months: 3.2 (1.1–9.9) 12 months: 2.8 (1.3–6.1)
Patel *et al.* (2003)	India	Infant health clinic, urban/rural population	171	EPDS cut-off 11/12	23%	6–8 weeks postpartum	*Underweight:* weight-for-age < 5th centile *Stunting:* height-for-age < 5th centile	6	*Underweight* [RR (CI)]: 2.3 (1.1–4.7) *Stunting* [RR (CI)]: 2.9 (1.3–6.8)	Reported adjusted for individual confounders. All associations remained significant
Tomlinson *et al.* (2006)	South Africa	Peri-urban, community based	147 (at 18-month follow-up data on 98 infants only)	SCID, major depressive episode	34.7%	2 months postpartum	*Weight:* mean WAZ (SD) *Height;* mean HAZ (SD)	18	*Weight* [mean WAZ (SD)]: Cases: –0.8 (1.74) Non-cases: –0.31 (1.13) $P = 0.051$ *Height* [mean HAZ (SD)]: Cases: –0.89 (1.91) Non-cases: –0.34 (1.28) $P = 0.13$	*Weight* [mean WAZ (SD)]: Cases: –0.8 (1.29) Non-cases: –0.31 (1.13) $P = 0.26$ *Height:* non-significant

RR, relative risk; OR, odds ratio; WAZ, weight-for-age *z*-score; HAZ, height-for-age *z*-score; SCAN, Schedules for Assessment in Neuropsychiatry; EPDS, Edinburgh Post-natal Depression Scale; SCID, Structured Clinical Interview for DSM-IV.

adjustment for confounders. Maternal antenatal depression was also associated with low birthweight, increased infant diarrhoeal episodes (but not acute respiratory illnesses) and incomplete immunization. The difference between the growth of infants born to mothers who were depressed at all points of assessment (chronic depression), when compared with those who were never depressed, was even more marked.

Patel *et al*. (2003) undertook a cohort study in a public district hospital serving a mixed urban/rural population of predominantly low socio-economic status. Infants and mothers were recruited at the infant 6–8 weeks' immunization visit. In total, 23% of mothers scored above cut-off on the EPDS, and a significantly higher proportion of the babies of this group, compared with those of non-depressed mothers, were underweight and stunted both at recruitment and at 6-month follow-up. The latter association persisted when confounders (socio-economic status, maternal and paternal education, infant birthweight, sex, feeding practice, infant illness in the first 6 weeks of life and prematurity) were accounted for.

Tomlinson *et al*. (2006) conducted a prospective cohort study in a deprived peri-urban district of Cape Town, South Africa. A total of 147 mothers/infants were recruited at 2 months postpartum. In total, 34.7% of the mothers had DSM-IV major depression. Attrition rates were high; infant weight was recorded on 130 infants at recruitment and only 98 at 18-month follow-up. For length, the figures were 122 and 96, respectively. The only positive finding was a near-significant association between maternal depression at 2 months and lower infant weight-for-age *z*-score at 18 months (mean difference 0.49, 95% CI –0.002 to 0.99, $P = 0.051$). However, this association disappeared once birthweight was accounted for.

Studies from developed countries

There is an older literature from developed countries describing the observation that the mothers of children diagnosed with 'non-organic failure-to-thrive' had significant psychosocial difficulties and problematic relationships with their infants. These studies have been criticized, however, on the basis that the samples were often recruited from specialist units and no attempt was made to control for the marked referral bias to these services (Wright & Birks 2000). Three recent UK studies have sought to examine the relationship again using community-based designs. These are shown in Table 3. The first is a case–control study that shares some of the methodological difficulties of earlier work; two are large-scale cohort studies.

O'Brien *et al*. (2004) used a matched case–control design based within a community child health service in North Staffordshire. Infants meeting 'failure to thrive' criteria were referred to the study by health visitors and matched to controls from computerized records. Home visits were then made, where growth data were verified and mothers were asked to complete screening measures of both depression and anxiety. In total, 196 cases and 567 controls were recruited. Mothers of cases were more likely to be high scorers on both the EPDS (OR 1.96, CI 1.13–3.38) and the anxiety component of the Hospital Anxiety and Depression Scale (OR 2.08, CI 1.33–3.25). The authors report evidence that health visitors did not preferentially refer infants of mothers about whose mental health they were concerned, although this remains a theoretical flaw in the study design.

The ALSPAC (Avon Longitudinal Study of Parents and Children) study followed a large birth-cohort recruited over 20 months in the Avon Health Authority area (south-west England) (Drewett *et al*. 2004). Over 80% of all eligible mothers in the defined catchment area were enrolled during pregnancy, giving a final infant cohort of 13 970. Subsequent data were collected by postal questionnaire and from routine computerized records. No significant association was found between either antenatal or post-natal maternal depression and infant underweight. Of note, antenatal depression was significantly associated with preterm birth. No interaction with socio-economic deprivation was found, although this was only measured using the proxies of home ownership and crowding.

In a second cohort study, the 'Gateshead Millenium Baby Study' (Wright *et al*. 2006), 774 infants in an urban area in north-east England were followed up prospectively over 13 months. The infants of mothers depressed at 2–3 months postpartum were more

Table 3. Studies from developed countries

	Country	Study design	Study setting	Sample size	Maternal mental health measure	Timing of maternal depression measure	Infant growth measure	Infant age at growth measurement (months)	Association between maternal depression and infant growth outcome (corrected for confounders)
Drewett *et al.* (2004)	UK	Cohort	Community health register	13 970	EPDS (postal questionnaire) – analysed at cut-off 12/13 and 15/16	Antenatally 18 and 32 weeks' gestation, post-natally at 2 and 8 months	*Weight faltering:* lowest 5% on growth measure (weight gain corrected for birthweight)	9	No significant association
Wright *et al.* (2006)	UK	Prospective cohort	Community health register	774	EPDS (cut-off 12/13)	2–3 months post-natally	*Weight faltering:* < 5th centile of thrive index (WAZ corrected for birthweight)	1.5, 4, 6, and 12	RR for infant weight faltering at 4 months: 2.5, $P = 0.046$ (association only found in socially deprived group). No association found at 12 months
O'Brien *et al.* (2004)	UK	Case–control	Community child health surveillance programme	Cases 196 Controls 567	EPDS (analysed at cut-off 8/9 and 12/13) HADS (anxiety component)	Cases: when infant age mean 7.7 months, Controls: mean 10.1 months	*Weight faltering:* weight fallen below 2nd centile or fallen across 2 centile channels	<24	EPDS (cut-off 12/13): OR for high score among mothers of cases 1.96 (CI 1.13–3.38) HADS (anxiety): OR for high score among mothers of cases 2.08 (CI 1.33–3.25)

RR, relative risk; OR, odds ratio; WAZ, weight-for-age *z*-score; HADS, Hospital Anxiety and Depression Scale; EPDS, Edinburgh Post-natal Depression Scale.

likely to have faltering weight at 4 months than the infants of low-scoring mothers (relative risk 2.5, $P = 0.046$). However, this difference was no longer present at 13 months. This association between maternal depression and infant weight faltering at 4 months was only present among subjects from areas of high social deprivation.

Explaining the heterogeneity of results between studies

The heterogeneity in results could be accounted for by actual differences in the relationship between maternal depression and infant growth in different countries/cultures, or by differences in methodology and study population. Specifically, these latter factors include: cross-sectional vs. cohort methodology, community- vs. clinic-based sampling, timing of recruitment of mothers/infants, method of measurement of maternal depression, and the extent to which potential confounding factors were accounted for. These possibilities are addressed below.

How can the association between maternal depression and poor infant growth be understood?

There are several ways by which maternal depression and infant growth impairment may be associated.

1. Confounding factors may lead to both maternal depression and infant undernutrition.

In a number of the studies described, the association between maternal depression and poor infant growth no longer remained significant after confounding factors, such as poverty, were accounted for. It could be that confounders were measured in these (and the other negative) studies but were ignored in the apparently positive studies. However, there were no factors measured in the negative studies that were not accounted for in the positive cohort studies by Patel *et al*. (2003) and Rahman *et al*. (2004a), including socio-economic status, maternal age and education, family size and birthweight (see below). Nevertheless, the gross socio-economic indicators used might not have captured the relevant factors impacting upon both maternal mood and infant growth. Also, none of the studies comprehensively assessed physical health, although Rahman *et al*. measured maternal BMI as a proxy for general maternal health/nutritional status. Depression is associated with poor physical health and, as such, a physical health problem affecting *both* mother and child could underlie *both* low maternal mood and low infant weight. Examples could include parasitic infection, TB (tubercolosis) and HIV/AIDS. Maternal anaemia has been associated with altered maternal mood and mother–infant interactions (Beard *et al*. 2005; Perez *et al*. 2005). None of the studies described have measured maternal haemoglobin. Other than in the study by Anoop *et al*. (2004), maternal intelligence was measured only by the proxy of educational level. It could also be that personality traits, such as introversion and neuroticism, that are recognized risk factors for depression, might also impact upon the mother's ability to provide adequate nutritional care.

2. Maternal depression as a causal risk factor for infant undernutrition.

It is possible that maternal depression affects the mother's ability to provide adequate nutritional care to her infant. Depression, especially when marked, may lead to fatigue, impaired concentration, psychomotor slowing and feelings of hopelessness and worthlessness. Such symptoms may lead to functional impairment affecting breastfeeding, weaning, hygiene and healthcare-seeking behaviours.

Patel *et al*. (2002) found that depressed mothers in Goa were more likely to have difficulties with breastfeeding, or to cease breastfeeding early. When weaning, depressed mothers may be less successful in preparing foods and persisting with feeding the infant. Poor infant growth may be caused by frequent or severe childhood illness. Rahman *et al*. (2007) found higher rates of diarrhoea (but not acute respiratory illness) among the infants of depressed mothers than non-depressed. Possible explanations for this include poor feeding hygiene or breastfeeding problems/cessation. This study also showed that the children of depressed mothers are less likely to have completed immunization [although this was not found by Harpham *et al*. (2005)]. A depressed mother

may also be less successful in accessing general health care for herself or her infant. Most maternal and child health programmes include significant amounts of health education and advice. As depression affects concentration and the learning of new material (Austin *et al*. 2001), depressed mothers may be impaired in their ability to benefit from this.

An alternative route by which maternal depression may affect infant nutrition is through its effect on mother–child interaction. Depressed mothers may be less emotionally sensitive and attuned, which, in turn, leads to apathy and withdrawal among the infants (Murray & Cooper 1997). In Jamaica, Baker-Henningham *et al*. (2003) found that maternal depression was associated with reduced stimulation of the child in the home. Both low levels of stimulation in the home and dysfunctional mother–child interaction have previously been shown to be associated with infant undernutrition (Gardner *et al*. 1999).

Infant attachment behaviours may also play a role. Although not conclusive, there are studies that have found higher rates of insecure attachment among the infants of depressed mothers (Murray & Cooper 1997). In addition, US researchers investigating the attachment styles of infants diagnosed with 'failure to thrive' have found higher rates of insecure attachment (including disorganized type) compared with controls (Ward *et al*. 2000). Similar findings were made among malnourished children in Chile (Valenzuela 1990).

The studies may also throw light on the timing of the interaction between maternal depression and infant growth. In part, the effect appears to be mediated antenatally. Both Rahman *et al*. (2004a) in Pakistan and Patel & Prince (2006) in India found antenatal depression to be associated with low birthweight. Results from developed countries have found a similar association but only in socially deprived groups (Hoffman & Hatch 2000; Rondo *et al*. 2003). The antenatal association could be the result of confounding factors, but may be mediated through the deleterious effect of mental disorder upon maternal physical health and healthcare-seeking behaviours during pregnancy. It has also been suggested that maternal stress and/or depression leads to disturbance of the hypothalamic–pituitary–adrenal axis, thus exerting a direct physiological effect upon the intrauterine environment (Field *et al*. 2006).

Given this association with low birthweight, it might be that lower post-natal weight and length among infants of depressed mothers reflects, not post-natal growth impairment, but adequate growth starting from a lower baseline. Baker-Henningham *et al*. (2003) found that the association disappeared once birthweight was accounted for and it is often difficult to get accurate birthweight measurements retrospectively in developing countries. For example, Harpham *et al*. (2005), in their multi-country cross-sectional study, were missing birthweight information in 80% of cases in Ethiopia. However, in the cohort studies in Pakistan and India, although birthweights were lower in the depressed groups, the association with post-natal weight/length remained significant after birthweight was accounted for in multi-variate analysis. Infants born small due to intrauterine growth retardation would normally be expected to track up towards their expected growth trajectory, but the differences between the groups increased, at least up to 6 months.

It has also been suggested that the timing of the impact of maternal depression on infant growth could help explain the heterogeneity in study results. If maternal depression does lead to impairment of infant care, one might expect the impact to be most evident early in the post-natal period. At this time, infant care is more exclusively the responsibility of the mother, particularly if she is breastfeeding, whereas other family/community members might share the burden after weaning. There is some support for this argument from the published studies. Among the cross-sectional studies, those in which the mean infant age was <12 months all found a significant association, whereas those with mean infant age of ≥12 months gave mixed results. However, Harpham *et al*. (2005) report that there was no difference in their outcomes if infant groups younger or older than 12 months were analysed separately. Anoop *et al*. (2004) found no association between infant growth at 10 months and *current* maternal depression, but did find an association with recalled depression in the immediate post-natal period. However, there must be concern regarding the reliability

of maternal recall of mood symptoms occurring during a period when transient mood disturbance is common ('baby blues'). The results of cohort studies suggest an effect that is most evident between 4 and 6 months, but which lessens after this. Rahman *et al*. (2004a) found the difference between groups to be widest at 6 months and to have narrowed by 12 months (although it remained significant). In the UK cohort study by Wright & Birks (2000), an association was found between maternal depression at 2–3 months and infant thrive index at 4 months, but not after this. An effect on growth that lessens after 6 months might also explain the negative result from the South African cohort study, in which infant outcomes were measured only at recruitment and 18 months (Tomlinson *et al*. 2006).

3. Caring for a child who is slow to develop/grow may cause maternal depression.

Maternal depression may result, of course, from the mother's worries and fears for her sickly child, and the stress of the extra effort she has to put in to ensure that her child takes on adequate nutrition. It may also be that a mother's sense of self-worth is threatened by the stigma of having a child who is not doing well. This pressure may be both external (i.e. disappointment or even overt criticism expressed by family or community) and internal (i.e. the self-perception by the mother of having 'failed'). Contact with healthcare services may exacerbate this; terms such as 'failure-to-thrive' and 'growth failure' may add to a mother's sense of being solely responsible for her child's difficulties. This effect may, in part, explain why O'Brien *et al*. (2004) found a strong maternal depression/infant growth association in their UK case–control study but no such association was found in the larger ALSPAC cohort study (Drewett *et al*. 2004).

4. The role of contextual factors.

The research currently published indicates that there is an impact of maternal depression on infant growth in Asia but not in Africa or South America (although the evidence base there is limited). In a high-income country (UK) the evidence is equivocal, with clear support only for a transient impact among the most socio-economically deprived. The difference between the UK and Asia supports the hypothesis that it is in a more 'hostile' environment (in terms of poverty, healthcare availability, etc.) that the functional impairment secondary to maternal depression impacts on infant nutrition. In the UK, there are universal surveillance programmes designed to detect infant weight faltering, there is easy access to safe and affordable formula feeding, and infant immunization coverage is sufficient to convey 'herd immunity' in the population. Screening programmes for maternal depression are also common. Under such conditions, problems of infant care are likely to be detected early and to have less-marked effects if missed. In conditions of extreme poverty, the association may also be absent. In an area affected by severe food insecurity, any measurable impact of maternal depression may be swamped by the impact of the lack of food. This might explain the failure to demonstrate an association in Ethiopia.

It may not just be economic indicators that differentiate the Asian context from other developing countries, but also socio-cultural factors. Harpham *et al*. (2005) conjecture that the role of women in Asia may be especially pressured, and motherhood particularly disempowering, in a manner that is not the case elsewhere. In this environment, a depressed mother may find it especially difficult to function adequately (sufficient to ensure that her child receives appropriate nutrition). The impact of maternal mental health may be one factor explaining the so-called 'Asian Paradox' whereby rates of malnutrition in the Indian subcontinent are higher than would be expected given food availability.

Of course, it is probable that there are multiple interacting processes mediating the association between maternal mental ill-health and infant nutrition/growth, both those described above and others not as yet identified (Fig. 1).

Further studies and policy implications

Further studies are clearly needed to answer the many questions raised by the research published to date. These will include prospective studies in developing countries outside of Asia, qualitative studies

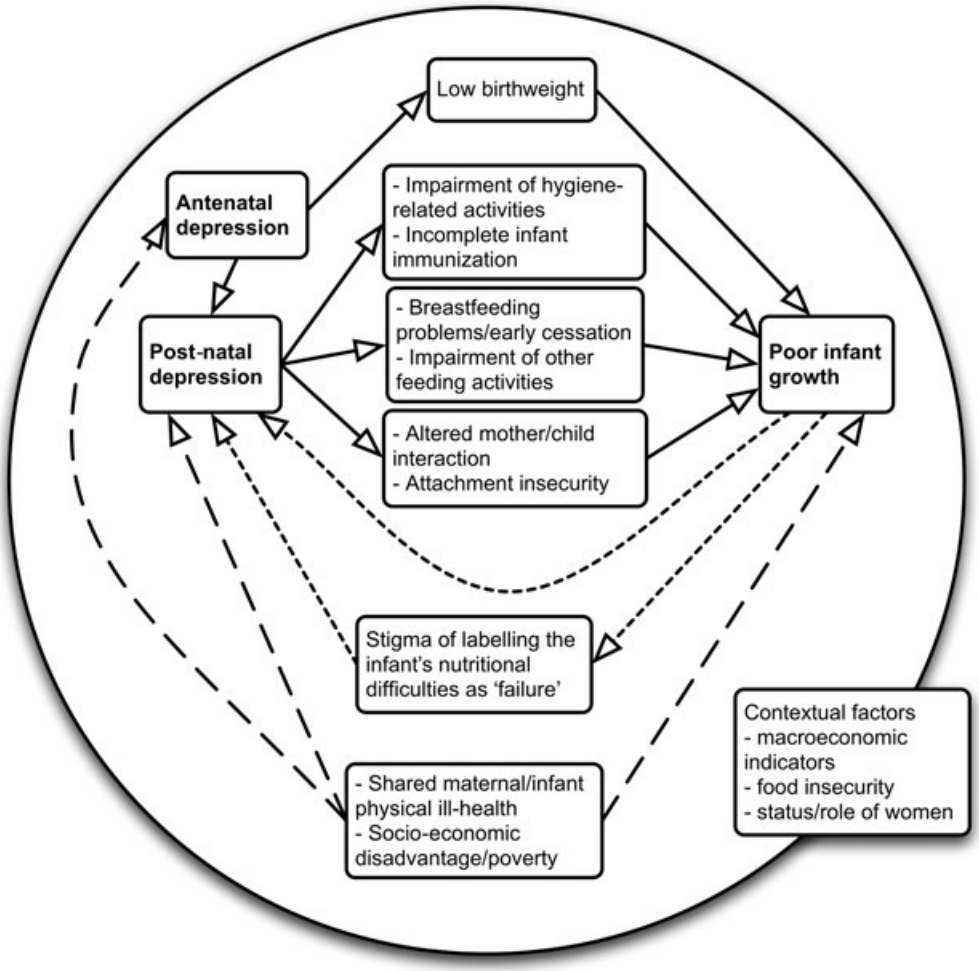

Fig. 1. Possible interactions between maternal depression and infant growth.

aimed at deepening understanding of mediating processes, and investigation of the importance of maternal depression in severe infant malnutrition. However, the best test of the hypothesis that maternal depression leads to poor infant growth will be a randomized controlled trial where depression is treated and the effect on the infant's growth measured.

There is no question, given the high prevalence of both maternal depression and infant undernutrition, that the finding of an association between them has significant public health implications. For example, based on their cohort study data, Rahman *et al*. (2004a) argue that, in rural Pakistan, the population-attributable risk of maternal depression for stunting at 12 months of age is 30% (95% CI 19–41). Such evidence suggests that, if global policies are to be comprehensive in tackling infant malnutrition, they must include strategies aimed at promoting the mental health of mothers.

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References

Anoop S., Saravanan B., Joseph A., Cherian A. & Jacob K.S. (2004) Maternal depression and low maternal intelligence

as risk factors for malnutrition in children: a community based case–control study from South India. *Archives of Disease in Childhood* **89**, 325–329.

Austin M.P., Mitchell P. & Goodwin G.M. (2001) Cognitive deficits in depression: possible implications for functional neuropathology. *British Journal of Psychiatry* **178**, 200–206.

Baker-Henningham H., Powell C., Walker S. & Grantham-McGregor S. (2003) Mothers of undernourished Jamaican children have poorer psychosocial functioning and this is associated with stimulation provided in the home. *European Journal of Clinical Nutrition* **57**, 786–792.

Beard J.L., Hendricks M.K., Perez E.M., Murray-Kolb L.E., Berg A., Vernon-Feagans L., *et al.* (2005) Maternal iron deficiency anemia affects postpartum emotions and cognition. *Journal of Nutrition* **135**, 267–272.

Cooper P.J., Tomlinson M., Swartz L., Woolgar M., Murray L. & Molteno C. (1999) Post-partum depression and the mother–infant relationship in a South African peri-urban settlement. *British Journal of Psychiatry* **175**, 554–558.

Cox J.L., Holden J.M. & Sagovsky R. (1987) Detection of post-natal depression. Development of the 10-item Edinburgh Post-natal Depression Scale. *British Journal of Psychiatry* **150**, 782–786.

Cox J.L., Murray D. & Chapman G. (1993) A controlled study of the onset, duration and prevalence of post-natal depression. *British Journal of Psychiatry* **163**, 27–31.

Drewett R., Blair P., Emmett P. & Emond A. (2004) Failure to thrive in the term and preterm infants of mothers depressed in the post-natal period: a population-based birth cohort study. *Journal of Child Psychology and Psychiatry, and Allied Disciplines* **45**, 359–366.

Field T., Diego M. & Hernandez-Reif M. (2006) Prenatal depression effects on the fetus and newborn: a review. *Infant Behavior and Development* **29**, 445–455.

First M., Spitzer R. M.G. & Williams J. (2002) *Structured Clinical Interview for DSM-IV-TR Axis I Disorders, Research Version, Non-patient Edition. (SCID-I/NP)*. New York State Psychiatric Institute: New York.

Gardner J.M., Grantham-McGregor S.M., Himes J. & Chang S. (1999) Behaviour and development of stunted and non-stunted Jamaican children. *Journal of Child Psychology and Psychiatry, and Allied Disciplines* **40**, 819–827.

Halbreich U. & Karkun S. (2006) Cross-cultural and social diversity of prevalence of postpartum depression and depressive symptoms. *Journal of Affective Disorders* **91**, 97–111.

Harpham T., Huttly S., De Silva M.J. & Abramsky T. (2005) Maternal mental health and child nutritional status in four developing countries. *Journal of Epidemiology and Community Health* **59**, 1060–1064.

Hoffman S. & Hatch M.C. (2000) Depressive symptomatology during pregnancy: evidence for an association with decreased fetal growth in pregnancies of lower social class women. *Health Psychology* **19**, 535–543.

de Miranda C.T., Turecki G., Mari Jde J., Andreoli S.B., Marcolim M.A., Goihman S., *et al.* (1996) Mental health of the mothers of malnourished children. *International Journal of Epidemiology* **25**, 128–133.

Murray L. & Cooper P.J. (1997) Postpartum depression and child development. *Psychological Medicine* **27**, 253–260.

O'Brien L.M., Heycock E.G., Hanna M., Jones P.W. & Cox J.L. (2004) Post-natal depression and faltering growth: a community study. *Pediatrics* **113**, 1242–1247.

Patel V. & Prince M. (2006) Maternal psychological morbidity and low birth weight in India. *British Journal of Psychiatry* **188**, 284–285.

Patel V., Rodrigues M. & DeSouza N. (2002) Gender, poverty, and post-natal depression: a study of mothers in Goa, India. *American Journal of Psychiatry* **159**, 43–47.

Patel V., DeSouza N. & Rodrigues M. (2003) Post-natal depression and infant growth and development in low income countries: a cohort study from Goa, India. *Archives of Disease in Childhood* **88**, 34–37.

Perez E.M., Hendricks M.K., Beard J.L., Murray-Kolb L.E., Berg A., Tomlinson M., *et al.* (2005) Mother–infant interactions and infant development are altered by maternal iron deficiency anemia. *Journal of Nutrition* **135**, 850–855.

Rahman A., Harrington R. & Bunn J. (2002) Can maternal depression increase infant risk of illness and growth impairment in developing countries? *Child: Care, Health and Development* **28**, 51–56.

Rahman A., Iqbal Z. & Harrington R. (2003) Life events, social support and depression in childbirth: perspectives from a rural community in the developing world. *Psychological Medicine* **33**, 1161–1167.

Rahman A., Iqbal Z., Bunn J., Lovel H. & Harrington R. (2004a) Impact of maternal depression on infant nutritional status and illness: a cohort study. *Archives of General Psychiatry* **61**, 946–952.

Rahman A., Lovel H., Bunn J., Iqbal Z. & Harrington R. (2004b) Mothers' mental health and infant growth: a case–control study from Rawalpindi, Pakistan. *Child: Care, Health and Development* **30**, 21–27.

Rahman A., Bunn J., Lovel H. & Creed F. (2007) Maternal depression increases infant risk of diarrhoeal illness: a cohort study. *Archives of Disease in Childhood* **92**, 24–28.

Rondo P.H., Ferreira R.F., Nogueira F., Ribeiro M.C., Lobert H. & Artes R. (2003) Maternal psychological stress and distress as predictors of low birth weight, prematurity and intrauterine growth retardation. *European Journal of Clinical Nutrition* **57**, 266–272.

Tomlinson M., Cooper P.J., Stein A., Swartz L. & Molteno C. (2006) Post-partum depression and infant growth in a South African peri-urban settlement. *Child: Care, Health and Development* **32**, 81–86.

Valenzuela M. (1990) Attachment in chronically underweight young children. *Child Development* **61**, 1984–1996.

Ward M.J., Lee S.S. & Lipper E.G. (2000) Failure-to-thrive is associated with disorganized infant–mother attachment and unresolved maternal attachment. *Infant Mental Health Journal* **21**, 428–442.

WHO (1994a) *A User's Guide to the Self Reporting Questionnaire (SRQ)*. World Health Organization: Geneva.

WHO (1994b) *SCAN: Schedule for Clinical Assessment in Neuropsychiatry*. World Health Organization: Geneva.

Wright C. & Birks E. (2000) Risk factors for failure to thrive: a population-based survey. *Child: Care, Health and Development* **26**, 5–16.

Wright C.M., Parkinson K.N. & Drewett R. (2006) The influence of maternal socio-economic and emotional factors on infant weight gain and weight faltering (failure to thrive): data from a prospective birth cohort. *Archives of Disease in Childhood* **91**, 312–317.